

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE  
NUMBER: 06-3A-0609 -X****SUBSYSTEM NAME: ACTIVE THERMAL CONTROL****REVISION: 0 02/04/88**

---

**PART DATA**

---

	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: WATER SPRAY BOILER ASSEMBLY	MC250-0019 ITEM 635
SRU	: NITROGEN TANK	SV766505-1

---

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
NITROGEN TANK****QUANTITY OF LIKE ITEMS: 3  
ONE EACH BOILER ASSEMBLY****FUNCTION:  
NITROGEN STORAGE TANK PROVIDING NITROGEN TO A DEMAND-FEED PRESSURE  
REGULATOR.**

**FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE**

**NUMBER: 06-3A-0609- 01**

**REVISION#: 1 08/25/98**

**SUBSYSTEM NAME: ATCS - WATER SPRAY BOILER**

**LRU: WATER SPRAY BOILER ASSEMBLY**

**ITEM NAME: NITROGEN TANK**

**CRITICALITY OF THIS**

**FAILURE MODE: 1/1**

**FAILURE MODE:**

RUPTURE

**MISSION PHASE:**

- PL PRE-LAUNCH
- LO LIFT-OFF
- OO ON-ORBIT
- DO DE-ORBIT
- LS LANDING/SAFING

**VEHICLE/PAYLOAD/KIT EFFECTIVITY:**

- 102 COLUMBIA
- 103 DISCOVERY
- 104 ATLANTIS
- 105 ENDEAVOUR

**CAUSE:**

CORROSION, POROSITY, VIBRATION, MECHANICAL SHOCK

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN**

- A) N/A
- B) N/A
- C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE  
NUMBER: 06-3A-0609- 01**

LOSS OF NITROGEN - UNABLE TO PROVIDE THERMAL CONTROL IN ONE APU LUBE OIL/HYD SYSTEM AND POSSIBLE DAMAGE TO ADJACENT WSB.

**(B) INTERFACING SUBSYSTEM(S):**

INTERFACE DEGRADATION - POSSIBLE DAMAGE TO APU/HYD INTERFACES. LOSS OF INSULATION BLANKET.

**(C) MISSION:**

POSSIBLE LOSS OF MISSION/CREW/VEHICLE IF SURROUNDING SUBSYSTEMS ARE DAMAGED

**(D) CREW, VEHICLE, AND ELEMENT(S):**

SAME AS (C)

---

**-DISPOSITION RATIONALE-**

---

**(A) DESIGN:**

TANK IS CONSTRUCTED OF TITANIUM WITH A 0.083 INCH WALL THICKNESS. DESIGN SAFETY FACTOR - PROOF PRESSURE OF 1.5 AND BURST OF 2.0. ACTUAL BURST PRESSURE 8,450 PSID (MAXIMUM OPERATING PRESSURE 3,180 PSID) EXCEEDS THE REQUIRED FRACTURE CONTROL CRITERIA WHICH IS 6,900 PSID BURST.

**(B) TEST:**

QUALIFICATION.

- TANK IS QUAL TESTED TO WITHSTAND 2000 PRESSURIZATION CYCLES (0-3180-0 PSIG).
- RANDOM VIBRATION TEST (BOILER AND VENT AREA) - ACCELERATION SPECTRAL DENSITY INCREASING AT RATE OF 6 DB/OCTAVE FROM 20 TO 50 HZ; CONSTANT AT 0.01 (G SQ)/HZ FROM 50 TO 2000 HZ FOR 48 MINUTES/AXIS (100 MISSION EQUIVALENCY). TEST PERFORMED WITH STORAGE TANK LOADED 100 PERCENT AND AT MAXIMUM OPERATING PRESSURE (FULL GN2 PRESSURE). HYDRAULIC AND APU LUBE OIL CIRCUITS PRESSURIZED TO MAX OPERATING PRESSURE THROUGHOUT TEST. PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION; NO ELECTRICAL CIRCUIT INTERRUPTIONS DURING TEST.
- SHOCK TEST - (PER MIL-STD-810, METHOD 516.1, PROCEDURE 1) 18 SHOCKS TOTAL, 6 EACH AXIS, AT 15 G'S PEAK VALUE FOR 11 MS NOMINAL DURATION WITH FULL WATER

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE  
NUMBER: 06-3A-0609- 01**

LOAD. PASS/FAIL CRITERIA: UNIT MUST PASS SUBSEQUENT PERFORMANCE RECORD TEST (INCLUDING WATER CIRCUIT PROOF AND LEAK CHECKS).

- PERFORMANCE RECORD TEST INCLUDES:
  - DESIGN POINT CHECK - VERIFICATION OF WSB SYSTEM OPERATING PARAMETERS DURING POOL BOILING (SEA LEVEL TESTING) AND SPRAY BOILING (AT ALTITUDE). TESTING INCLUDES A COMPLETE WATER LOAD EXPULSION TEST, PLUS A WATER CARRY OVER EFFICIENCY TEST WHICH COMPARES ACTUAL VS THEORETICAL WATER USAGE AT ALTITUDE ONLY WITH A KNOWN HEAT SINK.
- THERMAL CYCLE TEST - TESTED AT OPERATING CONDITIONS AT 70 TO 275 TO 70 DEG F WITH DWELL OF 10 MINUTES AT EACH LEVEL FOR 5 CYCLES. ALSO TESTED WITH WSB NOT OPERATING AT 70 TO -65 TO 70 DEG F WITH A DWELL OF 3 HOURS AT EACH LEVEL FOR 3 CYCLES. PASS/FAIL CRITERIA: NO DAMAGE OR PERMANENT DEFORMATION (INCLUDING TANK FAILURE). UNIT MUST PASS SUBSEQUENT PERFORMANCE TESTS (INCLUDING NITROGEN CIRCUIT PROOF AND LEAK CHECKS).
- NITROGEN CIRCUIT BURST TEST - TESTED AT 6900 PSIG FOR 1 MINUTE. PASS/FAIL CRITERIA: NO EVIDENCE OF LEAKAGE.

**ACCEPTANCE:**

- NITROGEN TANK COMPONENT TESTED PRIOR TO WSB ASSEMBLY AS FOLLOWS: PROOF TESTED WITH WATER AT 5200 PSIG AND LEAK TESTED WITH HELIUM AT 3450 PSIG.
- EXAMINATION OF PRODUCT - VERIFICATION OF WORKMANSHIP, FINISH, DIMENSIONS, CONSTRUCTION, CLEANLINESS, IDENTIFICATION, TRACEABILITY LEVEL AND PROCESSES PER DRAWINGS AND MC250-0019 (WSB PROCUREMENT SPEC).
- NITROGEN CIRCUIT PROOF TEST - TESTED AT 4770 PSIG FOR 15 MINUTES MINIMUM. PASS/FAIL CRITERIA: NO EVIDENCE OF PERMANENT DEFORMATION AND PASSAGE OF NITROGEN CIRCUIT LEAK CHECKS.
- HIGH SIDE N2 LEAK CHECK - TESTED AT 3180 PSIG WITH HELIUM. PASS/FAIL CRITERIA: 2.8 SCCM MAX HELIUM LEAKAGE.

**PRELAUNCH:**

- WSB IS OPERATING AT PRELAUNCH PHASE AND INTEGRITY IS VERIFIED BEFORE LAUNCH USING VEHICLE INSTRUMENTATION.

**GROUND TURNAROUND TEST**

- ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**{G} INSPECTION:**

**RECEIVING INSPECTION**

RAW MATERIALS ARE VERIFIED BY LAB ANALYSIS. VERIFICATION OF MATERIAL AND EQUIPMENT CONFORMING TO CONTRACTS IS PERFORMED BY INSPECTION.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 06-3A-0609- 01**

**CONTAMINATION CONTROL**

ANALYZE SYSTEM GN2 FOR CONTAMINATION. CONTAMINATION CONTROL PROCESSES A PLANS, AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

MANUFACTURING, INSTALLATION, AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. PART PROTECTION, COATING, AND PLATING ARE VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**

WELDING IS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

EXAMINATION OF SURFACE WELDS AND ENTIRE TANK FOR SURFACE AND SUBSURFACE DEFECTS IS VERIFIED BY X-RAY AND DYE PENETRANT INSPECTION.

TESTING MONITOR TESTS TO VERIFY FUNCTIONAL OPERATION IS WITHIN SPECIFIED LIMITS.

**HANDLING/PACKAGING**

PROPER HANDLING AND STORAGE ENVIRONMENT ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

**(E) OPERATIONAL USE:**

NONE

---

**- APPROVALS -**

---

EDITORIALLY APPROVED : BNA : J. Kimura 8-25-98  
TECHNICAL APPROVAL : VIA APPROVAL FORM : 95-CIL-009\_06-3A